




ORIGINAL RESEARCH article

Clinical pharmacokinetics: perceptions of Libyan hospital pharmacists about how it was taught and how it is applied

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Abstract: The application of clinical pharmacokinetics is the responsibility of all pharmacists providing pharmaceutical care. An appropriately applied clinical pharmacokinetic is expected to result in improved patient outcomes: decreased mortality, reduced length of treatment, reduced length of hospital stays and cost-savings. Data on the extent of pharmacokinetic application in Libyan hospitals remain scarce but available subjective evidence suggests that services related to clinical pharmacokinetics are mostly provided and performed by professionals other than clinical pharmacists. To explore the training background and perceptions of pharmacists on the pharmacokinetic course contents they received during their undergraduate pharmacy programs. Also, to determine the attitudes and barriers experienced by the pharmacists when applying pharmacokinetic principles in their current practice. This is a cross-sectional, descriptive study that was conducted between July 2018 and November 2019 using a self-administered survey. The study targeted hospital pharmacists practicing in different hospitals in Libya. A total of 104 pharmacists completed the questionnaire and submitted it back. The majority of participants learned pharmacokinetic courses as a mandatory course during undergraduate courses 81.0% with 37.0% selecting that course was taught as a separate course or courses. Around 80.0% of the participants agreed or strongly agreed that pharmacokinetic courses received in undergraduate studies are useful in pharmacy practice with over 75.0% of the participants agreeing or strongly agreeing on the relevance of those courses to their current clinical practice. About 40.0% of the participants described their current skills in allowing optimal patient care as being better. Different barriers were highlighted by the participants to allow sufficient clinical pharmacokinetic practice including lack of sufficient information, and lack of awareness of pharmacists' role and skills in applying clinical pharmacokinetic by other pharmacists and by other health care providers. Thus, this study shows that most practicing pharmacists showed a positive attitude to current pharmacokinetic practice and to the impact of their undergraduate studies on their successful practice. However, they have clearly addressed the room for improvement.

Introduction

Clinical pharmacokinetics (PK) is defined by the American Society of Health-System Pharmacists as the process of applying PK principles to determine the dosage regimens of specific drug products for specific patients to maximize the therapeutic outcomes and minimize toxicity [1, 2]. Pharmaceutical care is a vast developing field in the area of pharmacy and constitutes various areas and necessitates skills and knowledge to be adequately applied, and in this context the application of clinical PK is the responsibility of all pharmaceutical care providers [3]. In order to adequately apply clinical PK, a deep understanding and knowledge of absorption, distribution, metabolism and excretion profile of specific drugs in specific diseases and patient populations is crucial [2]. An appropriately applied clinical PK is expected to result in improved patient outcomes: reduced length of treatment, reduced length of hospital stays (LOHS), decreased morbidity, decreased adverse effects of drug therapy and cost-savings [4-7].

Therapeutic drug monitoring (TDM) as a core service related to the provision of clinical PK was revealed to positively affect patient care. It has been reported that pharmacists being part of TDM services for antiepileptic drugs resulted in significant improvement in the appropriateness of TDM use and substantial reduction in unnecessary costs [8, 9]. It is also suggested by another study that pharmacist-led TDM services had a positive impact on optimizing the initial dosing of vancomycin, amikacin and gentamicin [9]. Pharmacist-initiated TDM services have been assessed with aminoglycoside dosing and resulted in an increase in the likelihood of obtaining adequate peak concentrations, decreased the number and mean total doses administered and minimized changes in serum creatinine from baseline [10, 11]. TDMs and individualized dosing with theophylline dosing are found to achieve serum concentrations in therapeutic range and thus resulted in a rapid clinical improvement and resulted in lesser adverse events in comparison with conventional administration of the medication [10-12]. Pharmacists play a fundamental role in ensuring appropriate and cost-effective utilization of TDM while providing pharmaceutical care [6, 7].

Pharmacists are expected to use their knowledge and skills in identifying and managing arising issues related to TDMs which could be due to different reasons including drug interactions, non-adherence to prescribed medication and patient-specific factors [1, 2]. Research has shown that despite the valuable role pharmacists can play in optimizing clinical PK services, many pharmacists find it challenging to apply their PK knowledge and skills in clinical practice [13]. Different reasons are suggested to be related to this challenge; including lack of confidence; lack of sufficient training and lack of skills required to apply knowledge gained in undergraduate studies [14]. Lately, and in parallel to the Middle Eastern countries, pharmacy practice in Libya is undergoing a modest improvement in patient care and clinical practice. Different factors could be attributed to this improvement including the acceptance and demand on clinical pharmacy as practice instead of having the pharmacist role restricted to dispensing medications, also the improvement of the clinical pharmacy discipline in studies and practice made the pharmacist role approaching patient-centeredness more than before [15, 16]. Data on the extent of PK application in Libyan hospitals remain scarce but available subjective evidence suggests that services related to clinical PK are mostly provided and performed by professionals other than clinical pharmacists or pharmacists in general. Therefore, it is important to assess the pharmacist's perceptions of their education and skills and how this affects the clinical practice they are expected to apply [17]. An important start issue from the researcher's point of view is to start the assessment process by relating the knowledge and skills gained in undergraduate studies to what is actually applied in the existing clinical field. This is expected to guide the improvement process in the future to be started from what is taught and then reflected in what is applied. To the best of our knowledge, no previous studies aimed to assess the attitudes and practices of hospital pharmacists in Libya in this field have been published. An evaluation of the attitudes, practices and barriers is needed to understand the current situation and to aid in bridging the gaps in the practice [13]. Thus, the study aims to explore the training background and perceptions of pharmacists in

Libya on the PK course contents they received during their undergraduate pharmacy programs; the determine attitudes of, and the barriers experienced by, the pharmacists when applying PK principles in current practice.

Materials and methods

This is a cross-sectional, descriptive study that was conducted between July 2018 and Nov 2019 using a self-designed survey (see below). The study targeted hospital pharmacists practicing in several hospitals in Libya. These hospitals are Tripoli Central Hospital, Jalaal Maternity Hospital, Tajura Heart Hospital, Khadra Hospital, Abu-Setta Thoracic Diseases and Surgery Hospital, Metiga Hospital and Zawia Kidney Hospital. Pharmacists were included in the study if they were working as hospital pharmacists in clinical settings at mentioned hospitals in Libya for at least three years. This study is an extension of a previously conducted study in another country entitled Clinical Pharmacokinetics: perceptions of Hospital Pharmacists in Qatar about How it was Taught and How it is Applied [17]. The questionnaire of the original study was developed after a thorough literature review of similar instruments evaluating attitudes and practices of healthcare providers in different aspects [18-20]. Irrelevant fields and answering options were modified to suit pharmacists practicing in Libya.

The questionnaire consisted of three main categories other than demographics and professional characteristics. Categories were classified to assess: PK contents learned in the undergraduate curriculum (four multiple-choice items); 2 perceptions towards the PK contents and instructions received in the undergraduate curriculum (five items measured on a five-point Likert scale; strongly agree to strongly disagree); 3 applications of PK in current clinical practice (six items assessing the relevance of the PK courses received and the barriers faced towards application in practice). One open-ended question was included to assess perceived barriers in PK application. Face and content validation were performed in the initial study with three experts in the clinical pharmacy field and an expert in questionnaire development. The questionnaire was also reviewed and evaluated by a clinical pharmacy specialist in Libya. Questionnaire was randomly distributed to hospital pharmacists practicing in different hospitals in Libya through a contact person in each hospital to facilitate the distribution and collection of questionnaires.

Statistical analysis: Data were analyzed by IBM Statistical Package for Social Sciences (IBM SPSS Software) version 22. Descriptive and inferential statistics were applied for the data analyses. All the categorical variables were expressed as frequencies and percentages. The influence of respondents' professional and demographic factors on perception towards PK teaching and practice was tested using the Chi-square and Fisher's Exact tests. The level of significance was set as $p > 0.05$.

Results

Demographics and professional characteristics of the participants: A total of 104 pharmacists completed the questionnaire and submitted it back. Female participants constituted 77.8% of the whole study population with a majority of participants being in the age range of 20-30 years old (44.4%) and a bachelor's degree holder of 77.8%. More than 96.0% of the participants received their degree in Libya but had a variable range of experience of 59.0% had more than five years of experience. 66.0% of the participants received no pharmacy-related training after graduation **Table 1**.

Undergraduate pharmacokinetic courses: The majority of the participants learned PK courses as a mandatory course during undergraduate courses (81.0%) with 37.0% selecting that course was taught as a separate course/course. With regards to a number of PK courses received in undergraduate studies (48.0%) of the participants had the course as a single course with the remaining participants being taught the course through two or more

courses. Less than half of the participants (29.6%) described their PK course as being directed towards the clinical application of PK principles.

Table 1: Demographics and professional data of hospital pharmacists in Libya

| Characteristic | Frequency (%) |
|--|---------------|
| Gender | |
| Male | 23 (22.1%) |
| Female | 81 (77.8%) |
| Age in years | |
| 20-30 | 46 (44.2%) |
| 31-40 | 31 (29.8%) |
| 41-50 | 23 (22.1%) |
| > 50 | 04 (03.8%) |
| Highest academic degree | |
| BSc | 81 (77.8%) |
| MSc | 19 (18.26%) |
| Pharm D | 00.0 |
| PhD | 04 (03.8%) |
| Others | 00 |
| Country of graduation | |
| Libya | 100 (96.1%) |
| Others | 04 (03.9%) |
| Years of experience as hospital pharmacist | |
| <5 years | 42.6 (40.9%) |
| 6-10 years | 15.4 (14.8%) |
| 11-15 years | 23.0 (22.2%) |
| >15 years | 23.0 (22.2%) |

Table 2: Hospital pharmacists' perception towards pharmacokinetics contents and their applicability to clinical practice

| Perception Item | % | % | % | % | % |
|---|----------------|-------|---------|----------|-------------------|
| | Strongly agree | Agree | Neutral | Disagree | Strongly disagree |
| The undergraduate PK courses I received were useful to my current practice | 44.4 | 37 | 7.4 | 7.4 | 3.8 |
| The undergraduate PK courses I received were relevant to my current practice | 40.7 | 33.3 | 18.5 | 3.7 | 3.8 |
| The method used to teach PK courses at my pharmacy undergraduate studies was effective | 29.6 | 29.6 | 7.4 | 22.2 | 11.2 |
| The content of the PK courses I received at my pharmacy undergraduate studies was adequate | 22.2 | 11.1 | 25.9 | 37 | 3.8 |
| The depth of the PK courses taught at the undergraduate pharmacy studies was appropriate to prepare me for my future clinical roles | 22.2 | 18.5 | 25.9 | 29.6 | 3.8 |

Perceptions and opinions of participants towards PK course taught during undergraduate studies: As shown in **Table 2**, around 81.4% of the participants agreed or strongly agreed that PK courses received in undergraduate studies are useful in pharmacy practice with over 74.0% of the participants agreeing or strongly agreeing on the relevance of those course to their current clinical practice. With regard to teaching methods and approaches, almost 60.0% of the participants agreed or strongly agreed about the effectiveness of such methods. More than half of the participants did not agree on the sufficiency of PK courses in undergraduate studies (66.7%) nor on the capability of such courses to prepare students for clinical pharmacy practice (59.2%).

Application of PK in current clinical practice: In **Table 3**, hospital pharmacists described their utilization of the PK knowledge gained through undergraduate pharmacy degree programs in their current practice as Used most of the times (15.0%); used many times (22.0%) and used occasionally (26.0%).

Table 3: Utilization of pharmacokinetic knowledge gained through undergraduate pharmacy program

| Extent of utilization | Frequency (%) |
|------------------------|---------------|
| Used most of the times | 15.6 (15.0%) |
| Used many times | 22.88 (22.0%) |
| Used occasionally | 27.04 (26.0%) |
| Used rarely | 36.4 (35.0%) |
| Not used at all | 02.08 (02.0%) |

Perceived barriers and practice: Different barriers were highlighted by the participants to allow sufficient clinical PK practice including lack of sufficient information, lack of awareness of pharmacists' role and skills in applying clinical PK by other pharmacists and by other health care providers, as well as, lack of courses and education provided to enhance the skills and optimize the practice of hospital pharmacists.

Discussion

Although the majority of pharmacists in this study have highlighted the importance and relevance of their undergraduate PK courses to their current practice, a large portion of the sample did not feel that the knowledge and skills received were sufficient and capable of preparing them for clinical practice. Respondents have also identified several barriers rendering them unable to provide full and sufficient pharmacy practice service. Having the required equipment for valid and beneficial PK services is crucial for an outstanding practice [21-26]. Thus, addressing the concerns and barriers to the implementation of this service is warranted. Our cohort of pharmacists also pointed out the need for curriculum improvement and given most of the cohort sample belongs to graduates from Libyan universities following similar curriculums and teaching methods this highlights the need for a true review of the currently taught curriculum. Years of experience had an influence on some selections, as pharmacists who are fresh graduates (<5 years) had more positive attitudes and pointed relevance of undergraduate studies to their current practice.

This study showed similar findings to a previously conducted study by the author but in a different country (Qatar) at a period showing a new and evolving role of clinical pharmacy and clinical PK [15]. The previously conducted study highlighted barriers from the point of view of practicing pharmacists and concluded that certain gaps need to be filled for the optimal application of clinical PK. One of the most important gaps is making the scientific material taught in the undergraduate curriculum clinical and patient-oriented, filled with true applications and when possible, live simulations and clinical practice visits during undergraduate studies [27, 28]. To our knowledge, this is the first study evaluating perceptions of hospital pharmacists in Libya. The study targeted pharmacists practicing in a wide range of hospitals in Libya for pharmacists who are exposed

to the same or highly similar curriculum making it reflective of the research objective. This study is a starting point in the assessment of the influence of PK courses taught by Libyan universities on current practice. Further assessments and studies should be conducted for a comprehensive image before implementing changes, especially from the point of view of academicians and using objective measures to assess the current curriculum and how to improve it. Other published studies evaluating clinical pharmacokinetics teaching and application have been reviewed. A study entitled design and delivery of clinical pharmacokinetics in colleges and schools of pharmacy concluded that teaching methods have evolved in a noticeable manner in comparison to 2003 [29, 30]. Another recent study published in 2020 aimed at evaluating the impact of development in pharmacy education on pharmacy practice, concluded that new evolvement in pharmacy education had positively affected the pharmacy practice in hospital and community settings [31].

Conclusion: Most practicing pharmacists showed a positive attitude toward their current PK practice and the impact of their undergraduate studies on their successful practice. However, they have clearly addressed the room for improvement. This study can be used to guide future efforts to improve the current curriculum and to make it more practical and relevant to current practice.

Data availability statement: The raw data that support the findings of this article are available from the corresponding author upon reasonable request.

Author contributions: EAO & MNSS conceived, designed, performed the analysis of data and drafted and revised the final version of the manuscript. MNEE collected the data. Both authors approved the final version of the manuscript and agreed to be accountable for its contents.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Ethical issues: Including plagiarism, informed consent, data fabrication or falsification and double publication or submission were completely observed by the authors.

Author declarations: The authors confirm that all relevant ethical guidelines have been followed and any necessary IRB and/or ethics committee approvals have been obtained.

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